EE302 Spring 2004
Course Learning Objectives

LESSON 1: Course Introduction and Number Systems READING: DP 1-8, 16-20 and 28-35

a. Understand the course policy.
b. Be able to count in binary and hexadecimal number systems.
c. Understand how Binary Coded Decimal (BCD) and binary numbers differ.
d. Be able to perform conversions between decimal, binary, hexadecimal, and BCD number systems.
e. Understand what Gray Code is and how it is generated
f. Explain the difference between a logic high and logic low.
g. Explain the relationship between a logic operation and a logic gate.
h. Write Boolean expressions for OR, AND, NOT operations and draw the associate gate symbols.

LESSON 2: Logic Gates and Timing Diagrams READING: DP 36 and 48-56

a. Write Boolean expressions for NOR, NAND, XOR, and XNOR operations and draw the associate gate symbols.
b. Given a logic gate or logic expression, construct the associated truth table.
c. Given input waveforms for a logic gate, draw the output waveform.

LESSON 3: Combining Gates and Boolean Algebra READING: DP 39-42 and 58-81

a. Given a logic circuit composed of multiple gates, construct the associated truth table.
b. Given input waveforms for multiple, connected gates, draw the output waveform.
c. Determine the unsimplified Boolean expression for a logic circuit with multiple gates.
d. Explain universality as it applies to NAND gates, NOR gates, and a universal set.
d. Apply Boolean theorems to a complex Boolean expression in order to simplify to its simplest sum-of-products (SOP) form.
e. Explain the difference between sum-of-products from and product-of-sums form and understand why each is useful.
f. Define DeMorgan's Theorem and use it to simplify a logic expression and circuit.
g. Using universality and DeMorgan't Theorem, express any circuit using only NAND gates or only NOR gates.

LESSON 4: Karnaugh Maps READING: DP 82-93

a. Explain how a Karnaugh Map is setup and why the variables are in Gray Code order.
b. Minimize a Boolean expression or logic circuit of up to four variables using a Karnaugh map.
c. Discuss the advantages and disadvantages of using a Karnaugh map versus Boolean algebra to simplify a logic expression.
d. Use "don't care" conditions properly to obtain the minimal SOP expression that meets design requirements.

LESSON 5: Logic Design READING: DP 96-102 and 170-171

a. Derive a Karnaugh map or truth table which implements given design requirements.
b. Go from a truth table to a Karnaugh map to a Boolean expression to a simplified logic circuit which realizes the truth table.
c. Implement and test a designed logic circuit using a programmable logic device.
d. Understand what half-adders do and be able to explain their operation given a diagram.

LESSON 6: Flip-flops READING: DP 204, 209-220

a. Define the following terms: clock, synchronous, asynchronous, pulse-triggered, positive-edge-triggered, and negative-edge-triggered.
b. Know and understand the truth tables for a D flip-flop, and JK flip-flop.
c. Given a timing diagram for the inputs for a flip-flop, complete the timing diagram for the output.

LESSON 7: Registers and Counters READING: DP 230-240, 260-268

a. Understand the functioning of a ripple-counter using JK flip-flops and explain how a mid sequence reset will affect the counter.
b. Explain the difference between serial-in serial-out, serial-in parallel-out, parallel-in serial-out, and parallel-in parallel-out shift registers, including advantages and disadvantages.
c. Given the inputs for a flip-flop based shift register (Serial-In Parallel-Out), complete the timing diagram for the output.
d. Properly connect either D or JK flip-flops in a shift register configuration.

LESSON 8: Logic Capstone Practical Exercise

a. Using digital logic, design and implement a circuit which meets given design criteria.

LESSON 9: Computer Architecture I

a. Define and Identify the 5 basic components of a computer (I/O, ALU, Memory, Control Unit).
b. Define what makes a machine a computer.
c. Define the different functions of an ALU
d. Given the logic gates and flip-flops learned in the previous lessons , locate and analyze their function in the ALU.
e. Distinguish the difference between machine language, assembly language and higher level language when programming a computer.

LESSON 10: Computer Architecture II

a. Identify and describe the different hardware components of the computer issued to the Class of ’05.
b. Apply and evaluate each of the objectives from Lesson 9 to the computer issued to the Class of ’05.

LESSON 11: Transistor as a Switch, OpAmps and Diodes (Supplement)

a. Explain the function of a transistor including listing the basic parts.
b. Explain how a transistor can be used as a switch.
c. Describe the function of a diode
d. Given a simple AC circuit with a diode, graph the output.
e. Describe the function of an operational amplifier.
f. List and explain the rules for an operational amplifier.
g. Draw a circuit which implements an opamp as a summing amplifier.
h. Given a summing amplifier circuit, determine the output based on resistor values and input voltages.
i. Expalin how an opamp can be used as a comparator.

LESSON 12: Introduction to Communications READING: ECS 3-22 and 36-45

a. Describe the purpose of Communication.
b. Distinguish between the elements of a Communication System.
c. Give an example of the different Communication Channels.
d. Distinguish between a digital and an analog signal.
e. Discuss the differences between Broadband and Baseband
f. Identify where varies signals lie in the EM spectrum.
g. Calculate the wave length of a signal of a given frequency.
h. Calculate the Bandwidth of a signal, given a frequency range.
i. Compute the gain and attenuation of a signal, when given voltage in and voltage out.
j. Calculate gain and attenuation in cascaded systems.

LESSON 13: Frequency and Time Domain READING: ECS 87-98

a. Identify the period, frequency and peak voltage of a sine wave.
b. Differentiate between the harmonics in a sine wave and predict how they will affect a signal.
c. Compare the relationship of the frequency domain and time domain of a signal.
d. Demonstrate the use and purpose of a filter.
e. Plot the output of a low pass, high pass, band pass and band reject filter in the frequency domain.
f. Calculate the 3 dB down point, Vout, cutoff frequency, and bandwidth of the filter when given a circuit or a plot of the output of a filter.
g. Derive the time Equation for a signal given the frequency plot and vice versa.

LESSON 14: Review for 6-Week Exam

LESSON 15: Comp Time for Exam 1

LESSON 16: Amplitude Modulation READING: ECS 106-129

a. Calculate the modulation index and percentage of modulation of an AM signal given the amplitudes of the carrier and modulating signals.
b. Explain how the power in an AM signal is distributed between the carrier and the sideband.
c. Compute the carrier and sideband powers given the percentage of modulation.
d. Compute the sideband frequencies given the carrier and modulation signal frequencies.
e. Compare the time-domain and frequency-domain representations of an AM signal.
f. Analyze the main components of an AM signal given a plot of the signal.

LESSON 17: AM Modulation / Demodulation Circuits and Frequency Modulation READING: ECS 135-138 and 150-152, 176-178, 182-189, 193-195

a. Describe the operation of diode modulator circuits and diode detector circuits.
b. Arrange the components of an amplitude modulator given a list of components.
c. Explain the function of each component in the basic amplitude modulation circuit.
d. Arrange the components of an amplitude demodulator given a list of components.
e. Explain the function of each component in the basic amplitude demodulation circuit.
f. Calculate the modulation index of an FM signal given the Maximum deviation and Maximum Frequency.
g. Calculate the bandwidth of an FM signal using the modulation index and Carson's Rule.
h. List the Advantages and disadvantages of FM compared to AM.

LESSON 18: Data Conversion (ADC) READING: ECS 292-301 and 304-305 and 307-309

a. Describe a step-by-step account of the transmission of analog signals using digital techniques.
b. Explain how quantizing error occurs.
c. Describe the techniques used to minimize Quantizing Error and calculate the minimum sampling rate given the upper frequency limit of the analog signal to be converted.
d. List the advantages and disadvantage of the Flash Converter and the Successive Approximation converter and identify the components of each.
e. Design a Flash ADC given desired output levels, resistor values, comparitors and input signal.
f. Describe the benefits of Digital Communication.

LESSON 19: Data Conversion (DAC) READING: ECS 299-304 and Supplement

a. Describe the step-by-step process of retrieving the analog signal from the digitized version.
b. List the advantages and disadvantages of the Binary weighted DAC and identify its components.
c. Design a Binary weighted DAC, given a set of digital input levels, OpAmp, and resistor values.

LESSON 20: Serial and Parallel Conversion and Pulse Modulation READING: ECS 309-313 and 320-326

a. Describe the two methods of transferring data and identify each given a diagram.
b. Explain why a shift register is considered a series-parallel conversion.
c. Identify the components of a basic Pulse Code Modulation System and describe how it functions.
d. Define Pulse Modulation and state the benefits of using PM.
e. Identify the 3 types of PM given a diagrams of each signal and describe how each signal represents the original signal.

LESSON 21: Superhetrodyne Receivers READING: ECS 338-360

a. Explain how selectivity is obtained in a circuit and calculate the BW given frequency and Q.
b. Identify the key components of a Tuned Radio Frequency Receiver.
c. Identify the key components in a SuperHet Receiver and describe their function.
d. Trace a signal in the frequency domain from the antenna to the output.

LESSON 22: Noise READING: ECS 361-372

a. Calculate the Signal to Noise ratio given the Signal Power and Noise Power.
b. Predict if a signal will be received given a SNR and a Receive Sensitivity.
c. Identify the common sources of noise.
d. Calculate Thermal Noise.
e. Calculate the Noise Figure, Noise Temperature and Noise Factor of a receiver.

LESSON 23: Multiplexing and Demultiplexing READING: ECS 406-431

a. Explain why multiplexing techniques are necessary in communication systems.
b. Compare frequency division multiplexing with time division multiplexing.
c. Illustrate an example of FDM and TDM.
d. Identify the key components of a FDM telemetery transmitting system.
e. Identify the key components of a TDM system used to generate an PAM signal.
f. Define PCM, draw the diagram of a typical PCM multiplexer, and state the primary benefit of PCM over other forms of PM.

LESSON 24: Digital Transmission READING: ECS 441-453

a. Explain the difference between asynchronous and synchronous data transmission.
b. State the relationship between communications channel bandwidth and data rate in bits per second.
c. Calculate the required channel bandwidth given channel capacity and differentiate how this changes with Multiple Coding Levels.
d. Calculate the channel capacity of a channel affected by noise using the Shannon-Hartley fromula.

LESSON 25: Digital Modulation READING: ECS 453-465

a. Calculate the modulation index, given the frequency deviation of an FSK signal.
b. Formulate the binary equivalent of a sinusoidal plot using FSK an PSK.
c. Describe how DPSK and QPSK differ from BPSK.
d. Describe QAM and how it differs from BPSK.

LESSON 26: Error Detection and Correction READING: ECS 475-482

a. Compare and contrast redundancy, parity, block-check sequences, cyclical redundancy checks, and forward error correction
b. Calculate the correct parity bit (odd and even) given a sequence of bits.
c. Construct the mathematical expression used for CRC given a sequence of bits.
d. Describe the process of Forward Error Correction.
e. Calculate the minimum number of Hamming bits required and construct the resulting bit sequence using Hamming Code for Forward Error Correction.

LESSON 27: Protocols, the OSI Model, and Encapsulation READING: ECS 482-487

a. Be able to identify the basic components of a network.
b. Be able to define the basic terms associated with communications and computer networks.
c. Understand the layers of the OSI Model and explain what function each performs.
d. Explain the purpose of layering.
e. Explain what is meant by encapsulation and it advantages/disadvantages.

LESSON 28: Network Types and Topologies READING: ECS 505-506, 518-531

a. Be able to identify the logical and physical topologies of a typical network.
b. Draw and describe the basic Bus, Tree, and Star Topology.
c. Explain the pros and cons of each topology.
d. Be able to explain when each topology is appropriate.

LESSON 29: Network Hardware READING: ECS 509-516, 531, 557-560, 810-820

a. Compare and contrast the general characteristics of Unshielded Twisted Pair (UTP), Coaxial Cable and Optical Fiber.
b. Compare and Contrast a Layer 2 Switch and a Hub.

LESSON 30: Ethernet and CSMA/CD, Token Ring READING: ECS 518-531

a. Compare and Contrast the Medium Access Control (MAC) Layer Protocols.
b. Describe how the Ethernet Protocol works.
c. Describe how the Token Ring Protocol works.

LESSON 31: Review for 12-Week Exam

LESSON 32: Compensation Time for 12-Week Exam

LESSON 33: WAN Hardware READING: ECS 513-516

a. Explain the differences between: Repeaters, Bridges, Routers and Gateways.
b. Describe the contents of Routing Tables and their relation to routing algorithms.
c. Explain two methods of route discovery.
d. Describe the building and maintaining of routing tables.
e. List the requirements of a routing function

LESSON 34: Packet Switching and Circuit Switching READING: ECS 503-504, 536-538

a. Be able to compare and contrast circuit switching and packet switching networks.
b. Define and give examples of WAN and MAN.
c. Define and describe the circuit switched networks: SONET, DSL, ADSL, ISDN and CATV.
d. Define ATM and list the main features of the protocol.

LESSON 35: Internet and Addressing READING: ECS 532-539

a. Explain how the Internet got started
b. Describe the components that make up the Internet
c. Describe the IP address hierarchy and why it is hierarchical.
d. Explain how TCP/IP fits into the OSI Model.
e. Describe the function so f exterior gateways and interior gateways.

LESSON 36: Wireless LAN and PAN READING: ECS 916-928, 487-493

a. State the benefits and weakness of WLAN.
b. Identify three wireless LAN standards and identify which uses DSSS versus FH.
c. Define personal-area-network.
d. State the benefits, features, and applications of the PAN Bluetooth.
e. Name two common uses for infrared wireless communications.
f. Explain the process of radio frequency identification systems and give examples of their application.

LESSON 37: Networking Capstone Practical Exercise READING: ECS 507-508

a. Describe the E-mail paradigm and its implementation.
b. List the functions of web servers and browsers.
c. Describe the security threats to a network and counters to them.

LESSON 38: Antennas READING: ECS 595-616 and 622-627

a. Describe the function of an antenna.
b. Explain why polarization is important.
c. Compute the length of quarter-wavelength and half-wavelength antennas given frequency of operation.
d. Design a dipole antenna, and draw the equivalent circuit.
e. Identify the 3 dB down point, Point of Max Radiation, plane of dipole, Beamwidth, and ERP given a plot of the radiation pattern of an antenna.
f. Describe the ways in which antenna design can be modified to produce an optimal match between the impedances of a transmitter and an antenna.
g. Compute signal strength.
h. Describe the characteristic of directivity.
i. Describe how an antenna tuner works.

LESSON 39: Radio Wave Propagation READING: ECS 627-641

a. Describe the characteristics of Ground waves, sky waves, and space waves.
b. Define fading and diversity reception.
c. Compare and contrast Relection, Refraction, and diffraction.
d. Calculate the distance between the transmitting antenna and the horizon.
e. Calculate the Received Power.
f. Calculate the Path attenuation.

LESSON 40: Satellites and GPS READING: ECS 716-728 and 746-752

a. State the primary function of a geostationary satellite.
b. Define Azimuth angle and angle of elevation and use them to determine the settings for an antenna.
c. Compare the uplink frequency to the down link frequency and state which component of a satellite system uses each.
d. State the frequency band of most military satellites and radar systems.
e. State the accuracy of GPS.
f. Describe how GPS determines location.
g. Calculate the Power Received using the Link Budget Equation.

LESSON 41: Wrap-up and Big Picture Overview

LESSON 42: Course Critiques

LESSON 43: Final Exam Review

LESSON 44: Final Exam Review